

<div style="display: flex; justify-content: space-between;"> <div style="text-align: center;"> UTILITY PATENT APPLICATION TRANSMITTAL <small>(Only for new nonprovisional applications under 37 CFR 1.53(b))</small> </div> <div style="border: 1px solid black; padding: 2px;"> Attorney Docket No. 991059 </div> <div style="border: 1px solid black; padding: 2px;"> Total Pages </div> </div> <div style="border: 1px solid black; padding: 2px; margin-top: 5px;"> First Named Inventor or Application Identifier </div> <div style="border: 1px solid black; padding: 2px; margin-top: 5px;"> Akio NAKAJIMA </div> <div style="border: 1px solid black; padding: 2px; margin-top: 5px;"> Express Mail Label No. </div>	<div style="display: flex; justify-content: space-between;"> <div style="width: 40%;"> APPLICATION ELEMENTS FOR: WORKPIECE-TRANSFER DEVICE </div> <div style="width: 60%;"> ADDRESS TO: Assistant Commissioner for Patents BOX PATENT APPLICATIONS Washington, D.C. 20231 </div> </div>

1. ☒ Fee Transmittal Form (Incorporated within this form)
(Submit an original and a duplicate for fee processing)

2. ☒ Specification Total Pages [26]

3. ☒ Drawing(s) (35 USC 113) Total Sheets [10]

4. ☒ Oath or Declaration Total Pages [2]
 - a. ☒ Newly executed (original)
 - b. ☐ Copy from prior application (37 CFR 1.63(d))
(for continuation/divisional with Box 17 completed).
 - i. ☐ Deletion of Inventor(s)
Signed statement attached deleting inventor(s) named in prior application,
see 37 CFR 1.63(d)(2) and 1.33(b).

5. ☐ Incorporation by reference (useable if box 4b is checked)
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under
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incorporated by reference therein.

6. ☐ Microfiche Computer Program (Appendix)

7. ☐ Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary)
 - a. ☐ Computer Readable Copy
 - b. ☐ Paper Copy (identical to computer copy)
 - c. ☐ Statement Verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. ☒ Assignment Papers (cover sheet and document(s))

9. ☐ 37 CFR 3.73(b) Statement (when there is an assignee) ☒ Power of Attorney

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications
under 37 CFR 1.53(b))

Attorney Docket No.

991059

First Named Inventor or Application Identifier

Akio NAKAJIMA

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10. ☐ English translation Document (if applicable)

11. ☒ Information Disclosure Statement

☒ Copies of IDS Citations (PTO-1449 w/1 ref.)

12. ☐ Preliminary Amendment

13. ☒ Return Receipt Postcard (MPEP 503)

14. ☐ Small Entity Statement(s)

☐ Statement filed in prior application
Status still proper and desired.

15. ☒ Claim for Convention Priority

☐ [1] Certified copy of Priority Document(s)

a. Priority of _____ application no. _____ filed on _____ is claimed under 35 USC 119.

The certified copies/copy have/has been filed in prior application Serial No. _____.

(For Continuing Applications, if applicable).

16. ☐ Other _____

17. If a CONTINUING APPLICATION, check appropriate box and supply the requisite information:

☐ Continuation ☐ Division ☐ Continuation-in-part (CIP) of prior application no. ____/____

FEE TRANSMITTAL	Number Filed	Number Extra	Rate	Basic Fee
The filing fee is calculated below				\$760.00
Total Claims	18 - 20		x \$18.00	
Independent Claims	2 - 3		x \$78.00	
Multiple Dependent Claims			\$260.00	260.00
Basic Filing Fee				1020.00
Reduction by 1/2 for small entity				
Fee for recording enclosed Assignment			\$40.00	40.00
TOTAL				\$1060.00

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☐ [] Please charge our Deposit Account No. **01-2340** in the total amount of _____ to cover the filing fee and the _____ assignment recordation fee. A duplicate of this sheet is attached.

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18. CORRESPONDENCE ADDRESS

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WORKPIECE-TRANSFER DEVICE

Field of the Invention

The present invention relates to a workpiece-transfer device for loading a material workpiece, such as a sheet, a sheetmetal, in a workpiece-machining device and unloading a product workpiece therefrom.

Background of the Invention

A loader or an unloader annexed to a workpiece-machining device conventionally comprises a traveling body that travels in the direction in which a workpiece-machining device and a workpiece-storage device are separated from each other, the traveling body having suction pads to suck the top surface of a workpiece for transfer. Such a loader and an unloader are designed to be independent of each other or to share rails for the traveling body.

The conventional loader and unloader execute loading and unloading exclusively, so both devices must be installed in order to perform both of these operations, resulting in the complicated configuration of the entire device and increased costs. Due to the use of shared parts, the loader and unloader sharing the rails for the traveling body simplifies the configuration and reduces costs compared to exclusive devices that are independent of each other, but the degree of simplification and cost reduction are insufficient.

Therefore, attempts were made to develop devices capable of loading material workpieces and unloading product workpieces using the same traveling body. Nonetheless, under a configuration in which the traveling body travels in only one direction along the direction in which the workpiece-machining device and the workpiece-storage device are separated from each other, as in the conventional loader and unloader, if the device is used for both loading and unloading, the position at which material workpieces are stored is also used as the position to which product workpieces are unloaded. Consequently, in the workpiece-storage device at which material workpieces and product workpieces are stored, a mechanism is required that can be frequently moved to move a pallet in the direction orthogonal to the direction for each material, complicating the configuration of the workpiece-storage device and increasing costs. Although the material and product housing positions can be located parallel to each other in the above direction, the resulting processing line overextends and undesirably occupies a large area of the factory.

In addition, since the conventional unloader is designed to move the traveling body in only the above direction, if product workpieces obtained by cutting a material workpiece are to be sorted depending on their type or blanking condition, a sorting device that is moved in the direction orthogonal to the above direction is required in the workpiece-storage device. This also increases costs.

Furthermore, in the conventional loader, the traveling body can be moved in

only one direction, so when a material workpiece is positioned on a table of the workpiece-machining device, some of the suction pads must act as positioning pads that can be moved in diagonal directions relative to the traveling body, complicating the configuration.

An object of the present invention is to provide a workpiece-transfer device that has functions for loading and unloading workpieces without requiring the workpiece-storage device to have a function for replacing material and product workpieces with each other, and that requires only a simple configuration that entails low costs.

Another object of the present invention is to provide a square layout of the entire facility, including the workpiece-machining device and the workpiece-storage device, in order to more effectively use the floor area.

Yet another object of the present invention is to enable material workpieces to be loaded and positioned on the workpiece-machining device without requiring an exclusive positioning means such as positioning pads.

Summary of the Invention

A workpiece-transfer device according to the present invention is a workpiece-transfer device for loading a material workpiece in a workpiece-machining device and unloading a machined product workpiece from the workpiece-machining device, wherein the workpiece-transfer device includes a movement means with a rectangular coordinate system for moving a traveling body in a

first direction along the direction in which the workpiece-machining device and a workpiece-storage device stand in a line, as well as in a second horizontal direction orthogonal to the first direction, and wherein the traveling body includes a gripping means for gripping a material or product workpiece.

According to this configuration, after the gripping means of the traveling body grips a material workpiece in the workpiece-storage device, the traveling body can be moved in the first direction to load the material workpiece in the workpiece-machining device. In addition, after the gripping means of the traveling body grips a product workpiece machined by the workpiece-machining device, the traveling body can be moved in the first direction to unload the product material to the workpiece-storage device. In this case, moving the traveling body in the second direction can accommodate a difference between the loading positions of material and product workpieces in the workpiece-storage device in the second direction. This configuration provides both functions for loading and unloading workpieces without requiring the workpiece-storage device to have a function for replacing material and product workpieces with each other, and requires only a simple configuration and low costs.

According to the present invention, the workpiece-storage device comprises a product-housing section and a material-housing section provided parallel to each other in the second direction. The arrangement of the product- and material-housing sections may be set so as not to exceed the arrangement range of the workpiece-machining device along the second direction.

This configuration provides a square layout of the facility, including the workpiece-machining device, the workpiece-storage device, and the workpiece-transfer device. Such a square layout enables the floor area of the factory to be used more effectively.

According to the present invention, the workpiece-storage device has a product-housing section and a material-housing section, and the rectangular coordinate system movement means can move the traveling body to the product- and material-housing sections so that the traveling body can be moved into position and load a material workpiece gripped by the gripping means of the traveling body, relative to a positioning member of the workpiece-machining device.

The traveling body can be moved in the first direction and in the second direction orthogonal to the first direction, as described above, so by moving the traveling body, a material gripped by the gripping means of the traveling body can be positioned relative to the positioning member of the workpiece-machining device. This configuration eliminates the need for the traveling body to have an exclusive positioning mechanism used in loading materials, e.g., positioning pads, thereby further simplifying the configuration and reducing costs.

Brief Description of the Drawing

Figure 1 is a top view of a workpiece-machining facility in which a workpiece-transfer device according to one embodiment of the present invention

is combined with a workpiece-machining device and a workpiece-storage device.

Figure 2 is a front view of the workpiece-machining facility.

Figure 3 is a side view of the workpiece-machining facility.

Figure 4 is a top view showing the general operation of the workpiece-transfer device in the workpiece-machining facility.

Figure 5 is a top view showing a suction-pad arrangement of the workpiece-transfer device.

Figures 6A and 6B are partial front and side views of the suction-pad arrangement, respectively.

Figure 7A is a top view of an advancing mechanism of the suction pad, Figure 7B is a sectional view of the advancing mechanism, and Figure 7C is an exploded view of Figure 7A as seen from direction C.

Figures 8A and 8B are explanatory drawings each showing in top view a form of material-loading operation by the workpiece-transfer device.

Figures 9A and 9B are explanatory drawings showing in top view a form of material-unloading operation by the workpiece-transfer device.

Figures 10A to 10B and 10C are explanatory drawings showing in top view another form of material-unloading operation by the workpiece-transfer device.

Figures 11A and 11B are explanatory drawings showing in top view yet another form of material-unloading operation by the workpiece-transfer device.

Detailed Description of the Preferred Embodiments

One embodiment of the present invention is described in conjunction with the Figures 1 to 11. As shown in the top view in Figure 1, a workpiece-storage device 2 is installed at the side of a workpiece-machining device 1, and a workpiece-transfer device 3 for transferring a workpiece W (material workpiece W1 and a product workpiece W2) is installed between the workpiece-machining device 1 and the workpiece-storage device 2. The workpiece-machining device 1 and the workpiece-storage device 2 are placed at small intervals so that an auxiliary table 4 may be installed between these devices and so that a control panel 16 may be installed between them and in front of them.

The workpiece-machining device 1 comprises a table 5 on which the workpiece W is placed, a machining section 6 for machining the workpiece W on the table 5, and a workpiece-feeding device 7 for moving the workpiece W located on the table 5. In the workpiece-feeding device 7, a cross slide 11 capable of moving in the lateral direction (the direction of the X-axis) is provided in a carriage 10 that is moved on a rail 9 of a lower frame 8 in the longitudinal direction (the direction of the Y-axis), and a plurality of workpiece holders 12 for gripping the end of the workpiece W are installed on the cross slide 11. The lateral direction (the direction of the X-axis) is the direction in which the workpiece-machining device 1 and the workpiece-storage device 2 are arranged. The table 5 comprises a central fixed table 5a, a pair of fixed tables 5b placed on the respective sides of the fixed table 5a, and a movable table 5c between the central fixed table 5a and the lateral fixed tables 5b which is

moved back and forth together with the carriage 10.

The machining section 6 is installed between an upper frame 14 above the central fixed table 5a and the lower frame 8, and is covered with a machine body. The workpiece-machining device 1 comprises a turret punch press, and the machining section 6 is chiefly composed of a vertical pair of turrets 13 and a punch drive mechanism (not shown in the drawings) for punching, at a predetermined punch position P, punch tools (not shown in the drawings) held at a plurality of circumferential positions of the turret 13. In the machining section 6, a subhead 15 is installed near the turret 13 and parallel with the punch position P. The subhead 15 is a means for cutting off from the material workpiece W1 the product workpiece W2 obtained by machining the outer circumference of the material workpiece W1 and partly connected to the material workpiece W1. The subhead 15 is composed of an exclusive punch mechanism. An end locator 17 for positioning the loaded material workpiece W1 in the lateral direction is installed on the table 5 so as to be extended and withdrawn by a drive means such as a cylinder. The end locator 17 and the workpiece holder 12 act as a positioning member 16 when the material workpiece W1 is loaded in the workpiece-machining device 1.

The auxiliary table 4 has a fixed table 4a at the side of the workpiece-storage device 2 and a folding table 4b at the side of the workpiece-machining device 1 wherein the folding table 4b can be folded downward.

In the workpiece-storage device 2, a product-housing section 21 in which

the product workpieces W2 are stacked and a material-housing section 22 in which the material workpieces W1 are stacked are arranged in the direction orthogonal to the direction in which the workpiece-machining device 1 and the workpiece-storage device 2 are arranged. In this example, in addition to the product-housing section 21 and the material-housing section 22, a skeleton-housing section 23 is provided in which skeletons S are stacked. These housing sections 21 to 23 are arranged in the order of the product-housing section 21, the material-housing section 22, and the skeleton-housing section 23 relative to the front of the device. The skeleton S is a residual material obtained by cutting out the product workpiece W2 from the material workpiece W1 in the workpiece-machining device 1 and corresponding to the outer circumference of the material workpiece W1. The arrangement range of these housing sections 21 to 23 does not exceed the arrangement direction (the direction of the Y-axis) and range of the workpiece-machining device 1.

The product-housing section 21, the material-housing section 22, and the skeleton-housing section 23 are each configured by stopping a product pallet 21a, a material pallet 22a, and a skeleton pallet 23a, respectively, at predetermined positions in a workpiece-storage device body 2a. The pallets 21a to 23a can be moved back and forth on rails provided on the workpiece-storage device body 2a and are moved while being driven by a pallet-movement device 24. The pallet-movement device 24 is composed of, for example, endless chains connected to the respective pallets 21a to 23a and a motor that drives the

chains. The rail guiding the product pallet 21a is provided higher than the rail guiding the material pallet 22a, and the material pallet 22a can pass below the product pallet 21a (see Figure 3). Each of the pallets 21a to 23a is constantly stopped at specified positions and moved when the workpiece W etc. on the pallet is ejected.

The workpiece-transfer device 3 comprises a movable table 26 installed on the fixed table 25 and extending in the direction orthogonal to the advancing and retreating direction, a traveling body 27 installed so as to advance and retreat along the movable table 26, and a gripping means 28 for the workpiece W installed on the traveling body 27 (see Figure 4). The movable table 26 advances and retreats in the direction orthogonal to the direction (the direction of the Y-axis) in which the workpiece-machining device 1 and the workpiece-storage device 2 are separated from each other (the direction of the X-axis). The separation direction (the direction of the X-axis) is called a first direction, while the direction orthogonal to the separation direction (the direction of the Y-axis) is called a second direction. The direction in which the traveling body 27 is moved relative to the movable table 26 is the first direction (the direction of the X-axis). The fixed table 25 and the movable table 26 constitute a base 29 supporting the traveling body 27 in the orthogonal directions of the two axes, and the base 29 and drive and guide means for the respective directions constitute a movement means with a rectangular coordinate system 30 for moving the traveling body 27 in the orthogonal directions of the

two axes.

The fixed table 25 comprises a pair of fixed rails 25a extending along the lateral sides of the workpiece-storage device 2. The movable table 26 is shaped like a linear frame extending on the table 5 of the workpiece-machining device 1 like a cantilever, and is installed on the pair of fixed rails 25a via a pair of legs 26a so as to advance and retreat. The tip of the movable table 26 extends to the neighborhood of a side of the upper frame 14 of the workpiece-machining device 1. The movable table 26 has a rail extending in the longitudinal direction, and the traveling body 27 is installed so as to travel along the rail. The advancing drive of the movable table 26 and the traveling drive of the traveling body 27 are carried out by drive devices 31 and 32 (Figure 2), respectively. The movable table drive device 31 and the traveling body drive device 32 are each composed of, for example, a rack and pinion mechanism and a servo motor driving the pinion. The rectangular coordinate system movement means 30 is composed of the movable table drive device 31, the traveling body drive device 32, and the rails 25a guiding the movable table 26 and the traveling body 27. Accordingly, the drive devices 31 and 32 act as a drive device in the rectangular coordinate system movement means 30 for moving the traveling body 27 in the direction of each axis.

The traveling body 27 has a pad-mounting frame 33, on which suction pads 35 constituting a gripping means 28 are provided. The pad-mounting frame 33 is installed on the traveling body 27 so as to be elevated and lowered by an

elevating device 34 installed on the traveling body 27. The elevating device 34 is composed of, for example, a rack and pinion mechanism and a servo motor driving the pinion.

The gripping means 28 is composed of a suction-pad arrangement 36 comprising a plurality of suction pads 35 attached to the pad-mounting frame 33 and arranged so as to form a plain, and grippers 52 (Figure 5) mounted on the pad-mounting frame 33. The gripper 52 is principally used to eject the skeleton S. In addition, floaters 51 for separating the material are attached to the pad-mounting frame 33. The floater 51 magnetizes laminated material workpieces W1 to allow the top of these material workpieces W1 to be easily separated based on their magnetic repulsion.

As shown in Figure 5, the pad-mounting frame 33 is composed of a main frame 33a and stretching mounting frames 33b and 33c provided on the respective lateral sides of the main frame 33a. The main frame 33a is composed of a plurality of assembled frame materials 39 and 40. The lateral stretching frames 33b and 33c are attached to the main frame 33a via guide members 37 so as to be moved out and back by a stretching drive device 38. The guide 37 is composed of a guide rod 37a fixed to the stretching frames 33b and 33c, and a receiving member 37b provided in the main frame 33a to guide the guide rod 37a. The stretching drive device 38 comprises a fluid pressure cylinder device. The stretching drive device 38 may be composed of a rack and pinion mechanism and a motor instead of the cylinder device.

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The plurality of suction pads 35 are provided on the frame materials 39 extending in the longitudinal directions (the direction of the Y-axis) of the pad-mounting frame 33 and on the lateral stretching frames 33b and 33c, wherein the suction pads 35 are arranged in the longitudinal direction. Thus, the stretching frames 33b and 33c can be moved out and back to vary the interval between the suction pads 35 attached to the main frame 33a and the suction pads 35 attached to the stretching frames 33b and 33c. The interval is varied depending on the environment of the workpiece-machining device 1 or the workpiece-storage device 2 or the size or shape of the material workpiece W1 or the product workpiece W2.

The suction-pad arrangement 36 is designed so that when the traveling body 27 is located at its advancing end position and the stretching frame 33b located in the advancing direction of the traveling body (left of the drawing) is withdrawn, the stretching frame 33b is located near the turret 13 and the subhead 15, as shown in each of Figures 9 to 11.

The suction pads 35 constituting the suction-pad arrangement 36 are each of a vacuum suction type and are connected to a suction device using piping. Of these suction pads 35, suction pads 35a and 35b each comprises a group of small pads 41. Each of the small pads 41 is a suction pad smaller than the entire suction pad 35 and has a suction function. Individual suction paths 43 for the respective small pads 41 (see Figure 6) are branched from a single suction path but each have a constriction 44.

The suction pads 35a and 35b each comprising the group of small pads are concentrated in part of the suction-pad arrangement 36, constituting a small-pad-group concentrated section 42. The position of the small-pad-group concentrated section 42 preferably corresponds to the position of a product workpiece-ejection section A of the workpiece-machining device 1. In this example, the small-pad-group concentrated section 42 is located near one corner of the suction-pad arrangement 36, specifically, near the workpiece-machining device 1 and the corner at the bottom of the drawing.

In addition, the small-pad-group concentrated section 42 has the suction pads 35a and 35b arranged according to a specified criterion. The specified criterion is that, for example, the suction pads 35a and 35b are set so as to form a staggered arrangement with the general suction pads 35 and to have a smaller arrangement interval than the other general suction pads 35, as shown in Figure 5.

At least one (in the illustrated example, one) of the suction pads 35a and 35b constituting the small-pad-group concentrated section 42 is an advancing suction pad 35a that can advance from the small-pad-group concentrated section 42. One of the remaining suction pads 35b is attached to the stretching frame 33b, and the other remaining suction pads 35a are attached to a concentrated section mounting member 45 provided on the main frame 33a.

The advancing suction pad 35b is attached to the stretching frame 33b via an advancing mechanism 46. The advancing mechanism 46 moves the advancing

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suction pad 35b back and forth relative to the small-pad-group concentrated section 42 and is composed of a swiveling arm 47 with the advancing suction pad 35b attached to its tip and an advancing drive means 48 for swiveling the swiveling arm 47 back and forth. The swiveling arm 47 is attached to the stretching frame 33b via a support member 50 so as to swivel horizontally around a support shaft 49 between a retreating position at which the arm extends along the stretching frame 33b as shown by the solid line in Figure 5 and an advancing position at which the arm protrudes and swivels from the stretching frame 33b through a predetermined angle (e.g., 90 degrees) as shown by the chain line in Figure 5. The advancing drive means 48 consists of a fluid pressure cylinder device. Since the swiveling arm 47 is swiveled to allow the advancing suction pad 35b to advance as described above, the advancing suction pad 35b can advance to between the turret 13 and subhead 15 of the workpiece-machining device 1 while the traveling body 27 is located at its advancing end.

Operations of the workpiece-transfer device 3 of the above configuration are described. First, loading and unloading operations are explained in brief. In the material-housing section 22 of the workpiece-storage device 2, material workpieces W1 are stacked on the material pallet 22a so as to form a lamination. To load the material workpieces W1 in the workpiece-machining device 1, the traveling body 27 is moved in directions X and Y so that the suction-pad arrangement 36 of the traveling body 27 is located above the material workpieces W1 in the material-housing section 22. The traveling body 27 is moved in the

direction of the Y-axis by moving the movable table 26 in the direction of the Y-axis. (in the following description of operations, the description "the movement of the traveling body 27 in the direction of the Y-axis" also refers to the movement of the traveling body 27 effected by moving the movable table 26 in the direction of the Y-axis.) Then, the suction-pad arrangement 36 is lowered from the traveling body 27 to allow each suction pad 35 of the suction-pad arrangement 36 to suck the material workpiece W1. Subsequently, the suction-pad arrangement 36 is elevated again.

As described above, while the traveling body 27 is gripping the material workpiece W1, the traveling body 27 is moved toward the workpiece-machining device 1 and the movable table 26 is moved in the direction of the Y-axis. Consequently, the suction-pad arrangement 36 is lowered to load the material workpiece W1 in a predetermined loading position on the table 5 of the workpiece-machining device 1. In this example, the predetermined loading position is a position at which when the carriage 7 is located at its retreating end, two sides of the material workpiece W1 are in contact with the workpiece holder 12 and the end locator 17, respectively, as shown in Figure 1. A reference position for this loading position corresponding to a corner of the workpiece is shown in Figure 1 as an L-shaped mark M1. The material workpiece W1 is pressed against the workpiece holder 12 and the end locator 17 by moving the traveling body 27 in directions X and Y after the material workpiece W1 has been lowered onto the table 5.

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The product workpiece W2 obtained by the workpiece-machining device 1 machining the material workpiece W1 is ejected from the predetermined product workpiece-ejection section A on the table 5 of the workpiece-machining device 1 or an arbitrary ejection position. When the subhead 5 is used to cut off the product workpiece W2, the predetermined product workpiece-ejection section A is near the subhead 5 as described above. The ejection is carried out by moving the traveling body 27 to the ejection section or position, lowering the suction-pad arrangement 36 to suck the product workpiece W2, elevating the suction-pad arrangement 36, then moving the traveling body 27 to above the product-housing section 21 of the workpiece-storage device 2, and lowering the pad arrangement 36 to release the sucking of the suction pads 35. When the workpiece-machining device 1 is used to cut out a plurality of product workpieces W2 from the material workpiece W1, the product materials W2 are stacked in the product-housing section 21 so as to be arranged in the blanking condition for the material workpiece W1. When the product workpieces W2 are stacked in this manner, this can be freely carried out by moving the traveling body 27 because it can be moved in the orthogonal directions of the two axes (directions X and Y).

The skeleton S remaining on the table 5 after the machining by the workpiece-machining device 1 is unloaded by using the gripper 51 provided on the traveling body 27 to grip an edge of the skeleton S and moving the traveling body 27 over the table 5 and the auxiliary table 4 to the skeleton-housing

section 23.

Next, the loading and unloading operations are explained in detail. Figure 8 shows the various forms of the suction-pad arrangement 36 during the material loading. Figure 8A shows a case in which the stretching frames 33b and 33c located on the respective sides of the suction-pad arrangement 36 are moved outward for unloading, i.e., the interval between the suction-pad arrangement and the suction pads on both sides is increased for unloading. Figure 8B shows a case in which the interval between the suction-pad arrangement and the suction pads on one side is increased for unloading, and Figure 8C shows a case in which the interval between the suction-pad arrangement and the suction pads on both sides is reduced for unloading. Figures 8A to 8C show the material workpieces W1 of three different sizes and shapes.

As shown in these figures, by increasing or reducing the suction pad interval of the suction-pad arrangement 36, the material workpiece 1 can be appropriately transferred depending on its size and shape, and can be loaded depending on the environment of the workpiece-machining device 1 without the needs for extra space for the suction-pad arrangement 36. For example, while the traveling body 27 is located at its advancing end closer to the workpiece-machining device 1, the material workpiece W1 can be loaded in a predetermined loading position at which the material workpiece W1 abuts on the end locator 17, regardless of the size and shape of the workpiece W1 and without the interference of the suction-pad arrangement 36 with the upper frame 14 of the

workpiece-machining device 1.

For loading, in any of the cases shown in Figures 8A to 8C, only the general suction pads 35 of the suction-pad arrangement 36 may be used for suction, while the suction pads 35a and 35b in the group of small pads are stopped from suction. Alternatively, all the suction pads 35, 35a, and 35b may be used for suction.

Figures 9 to 11 show the various forms the suction-pad arrangement 36 during product unloading. These figures all show a case in which the material workpiece W1 is cut into a plurality of or small product workpieces W2 and also show that the product workpieces W2 are located in the product-workpiece-unloading section A of the workpiece-machining device 1. In these figures, the suction pads 35 labeled with NG are stopped from suction by blocking the suction path. For example, in Figures 9A, 10A, and 11A, the suction pads 35 in the right end row come in contact with the product workpiece W2, and some of them also come in contact with the material workpiece W1. The suction pads 35 located at such positions may affect the operation if used for suction, so they are prevented from performing that function.

As shown in each of these figures, to unload the product workpieces W2 smaller than the material workpiece W1, one or both of the stretching frames 33b and 33c are withdrawn to reduce the interval between the suction pads on the respective sides in order to reduce the width of the suction-pad arrangement 36. Thus, when the product workpieces W2 are placed in the product-housing section

21 of the workpiece-storage device 2, this operation can be performed without the interference of the suction-pad arrangement 36 with the workpiece-storage device body 2a located around the workpiece-storage device 2 and consisting of frames. That is, when the product workpieces W2 are placed in the product-housing section 21, the suction-pad arrangement 36 must be situated off the center of the product-housing section 21 in order to place the plurality of product workpieces W2 in the blanking condition. Consequently, if there is a standing obstacle such as the workpiece-storage device body 2a of the workpiece-storage device 2 around the product-housing section 21, it is likely to interfere with the suction-pad arrangement 36. Such interference can be prevented by reducing the width of the suction-pad arrangement 36. In addition, in transferring a large material workpiece W1, stable transfer can be carried out by spreading the suction-pad arrangement 36 to maximize the suction area.

In addition, in the suction-pad arrangement 36, some of the suction pads 35a and 35b are composed of the group of small pads and the constriction 44 is provided for the suction path 43 of each small pad 41 (Figure 6A). Thus, even if holes such as punch holes are formed in the product workpiece W2 and the suction pads 35a and 35b correspond to these holes, this product workpiece W2 can be reliably sucked and transferred without causing negative pressure leakage. In addition, since the suction pads 35a and 35b comprising the group of small pads are concentrated in part of the suction-pad arrangement 36, even a small product workpiece W2 such as that shown in Figure 10C or 11A or 11B can

be reliably sucked and transferred.

Some of the suction pads 35b in the small-pad-group concentrated section 42 of the suction-pad arrangement 36 are further attached to the swiveling arm 47 so as to advance from the small-pad-group concentrated section 42. Accordingly, in the case of a small product workpiece W2 such as that shown in Figure 10C or 11A, the advancing suction pads 35b is moved to between the turret 13 and the subhead 15 to enable even and more reliable suction. In addition, as shown in Figure 11B, the present device can suck even a small product workpiece W2 that is small enough to fit between the turret 13 and the subhead 15 and that can only be sucked by one suction pad. By withdrawing the advancing suction pads 35b toward the pad-mounting frame 33 when not required, these suction pads 35b are prevented from interfering with the upper frame 14 of the workpiece-machining device 1 or the workpiece-storage device body 2a of the workpiece-storage device 2 during the movement of the suction-pad arrangement 36.

The workpiece-transfer device according to the present invention is a workpiece-transfer device for loading a material workpiece in a workpiece-machining device and unloading a machined product workpiece from the workpiece-machining device, wherein the workpiece-transfer device includes a movement means with a rectangular coordinate system for moving a traveling body in a first direction along the direction in which the workpiece-machining device and a workpiece-storage device stand in a line as well as in a second horizontal direction orthogonal to the first direction, and wherein the traveling body

includes a gripping means for gripping a material or product workpiece. This configuration provides both functions for loading and unloading workpieces without requiring the workpiece-storage device to have a function for replacing material and product workpieces with each other, and requires only a simple configuration and low costs.

If the workpiece-storage device comprises a product-housing section and a material-housing section provided in parallel in the second direction and the arrangement of the product and material-housing sections is set so as not to exceed the arrangement range of the workpiece-machining device along the second direction, then this configuration provides a square layout of the entire facility, including the workpiece-machining device and the workpiece-storage device, thereby enabling the floor area of the factory to be used more effectively.

In addition, if the rectangular coordinate system movement means can move the traveling body to the product and material-housing sections so that the traveling body can be moved into position and load a material workpiece gripped by the gripping means of the traveling body, relative to a positioning member of the workpiece-machining device, then this configuration can position and load the material workpiece on the workpiece-machining device without requiring an exclusive positioning mechanism such as positioning pads.

Claims;

1. A workpiece-transfer device for loading a material workpiece in a workpiece-machining device and unloading a machined product workpiece from the workpiece-machining device, characterized in that the workpiece-transfer device includes a movement means with a rectangular coordinate system for moving a traveling body in a first direction along the direction in which the workpiece-machining device and a workpiece-storage device stand in a line as well as in a second horizontal direction or thogonal to the first direction, and in that said traveling body includes a gripping means for gripping a material or product workpiece.

2. A workpiece-transfer device as in Claim 1, characterized in that said workpiece-storage device comprises a product-housing section and a material-housing section provided in parallel in said second direction, and in that the arrangement of the product and material-housing sections is set so as not to exceed the arrangement range of said workpiece-machining device along the second direction.

3. A workpiece-transfer device as in Claim 1 or Claim 2, characterized in that said workpiece-storage device comprises a product-housing section and a material-housing section, in that said rectangular coordinate system movement means can move said traveling body to said product and material-housing sections so that said traveling body can be moved to position and load a material workpiece gripped by the gripping means of said traveling body, relative to a

positioning member of said workpiece-machining device.

4. A workpiece-transfer device for loading a material workpiece in a workpiece-machining device and unloading a machined product workpiece from the workpiece-machining device, characterized by comprising one workpiece-gripping means.

5. A workpiece-transfer device as in Claim 4, characterized in that said workpiece-gripping means is provided on a traveling body that travels between the workpiece-machining device and a workpiece-storage device capable of storing material and product workpieces.

6. A workpiece-transfer device as in Claim 4 or Claim 5, characterized in that said workpiece-gripping means comprises a plurality of suction pads.

7. A workpiece-transfer device as in Claim 6, characterized in that said product workpiece is a small workpiece partially cut off from a material workpiece by the workpiece-machining device, in that said workpiece-gripping means uses a large number of suction pads to load a material workpiece in the workpiece-machining device, while using fewer suction pads than that used in the loading of the material workpiece to unload a product workpiece from the workpiece-machining device.

8. A workpiece-transfer device as in Claim 7, characterized in that a small number of suction pads closer to the workpiece-machining device are used to unload a product workpiece.

9. A workpiece-transfer device as in Claim 6, characterized in that some of

the plurality of suction pads each comprise a group of small pads, and in that a constriction is provided for a suction path for the individual small pad.

10. A workpiece-transfer device as in Claim 9, characterized in that the suction pads comprising a group of small pads are placed closer to the workpiece-machining device.

11. A workpiece-transfer device as in Claim 10, characterized in that the suction pads placed closer to the workpiece-machining device and comprising a group of small pads are first selected in unloading a product workpiece.

ABSTRACT OF THE DISCLOSURE

The present invention provides a workpiece-transfer device that has functions for both loading and unloading workpieces, without requiring a workpiece-storage device to enable a function for replacing material and product workpieces with each other, and that requires only a simple configuration and low costs. A workpiece-transfer device loads a material workpiece W1 in a workpiece-machining device 1 and unloads a product workpiece W2 from the workpiece-machining device 1. A movement means with a rectangular coordinate system 30 is provided to move a traveling body 27 in a first direction along the direction in which the workpiece-machining device 1 and a workpiece-storage device 2 stand in a line (direction X) as well as in a second horizontal direction orthogonal to the first direction (direction Y). The traveling body 27 includes a gripping means 28 for gripping a material or product workpiece W1 and W2.

FIG. 1

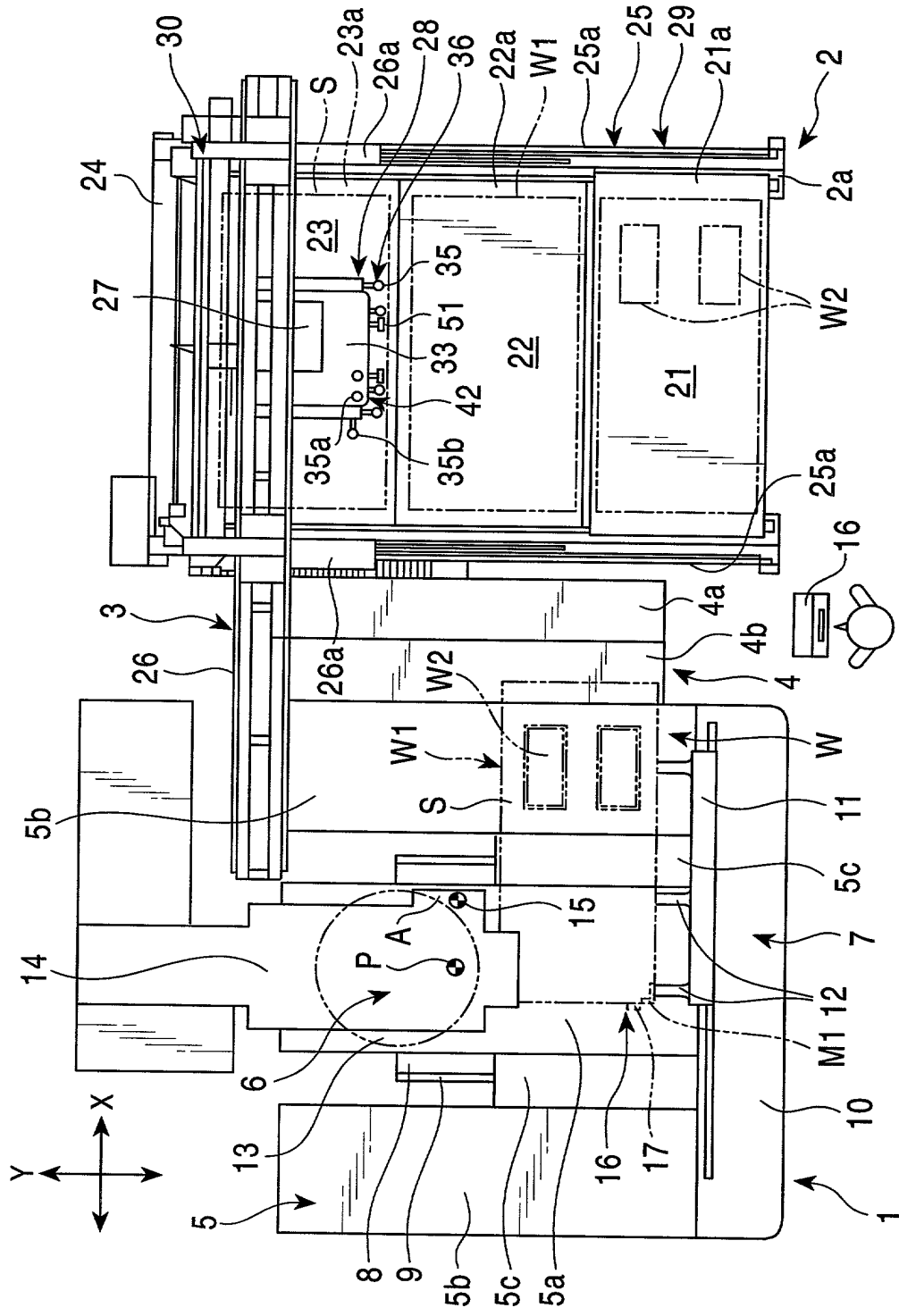


FIG. 3

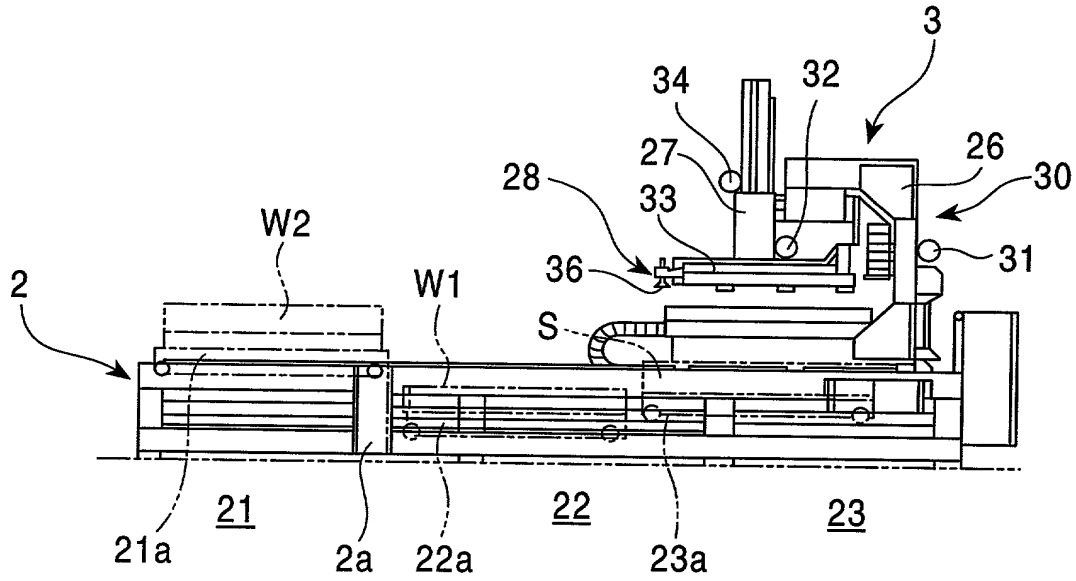


FIG. 4

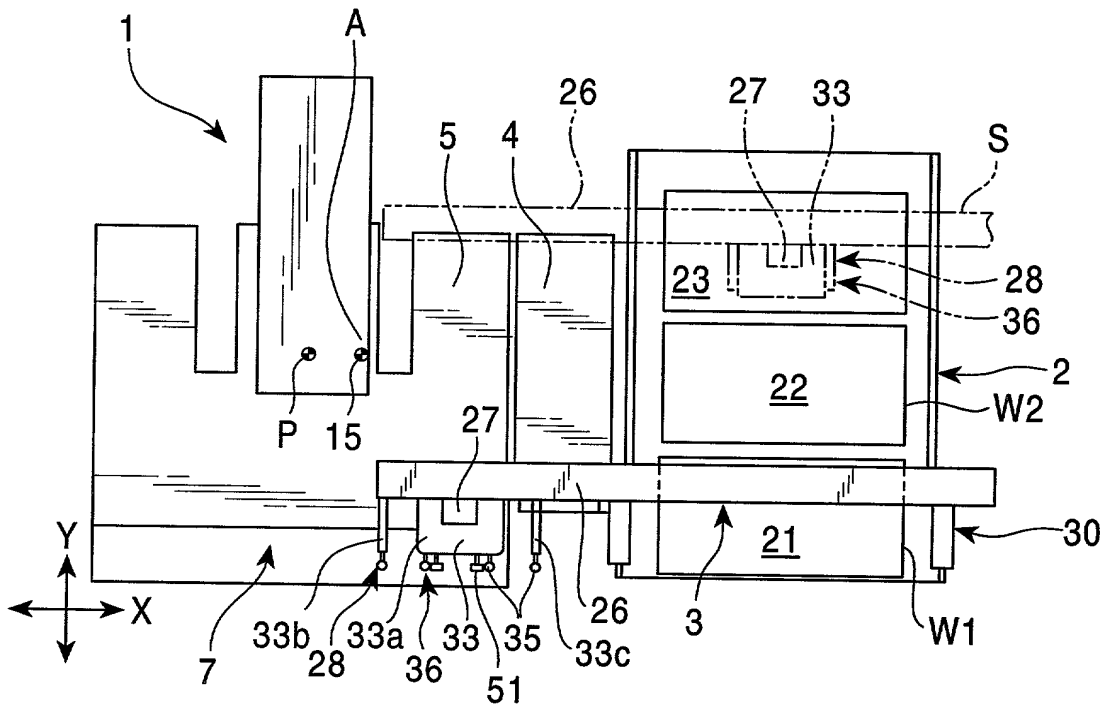


FIG. 5

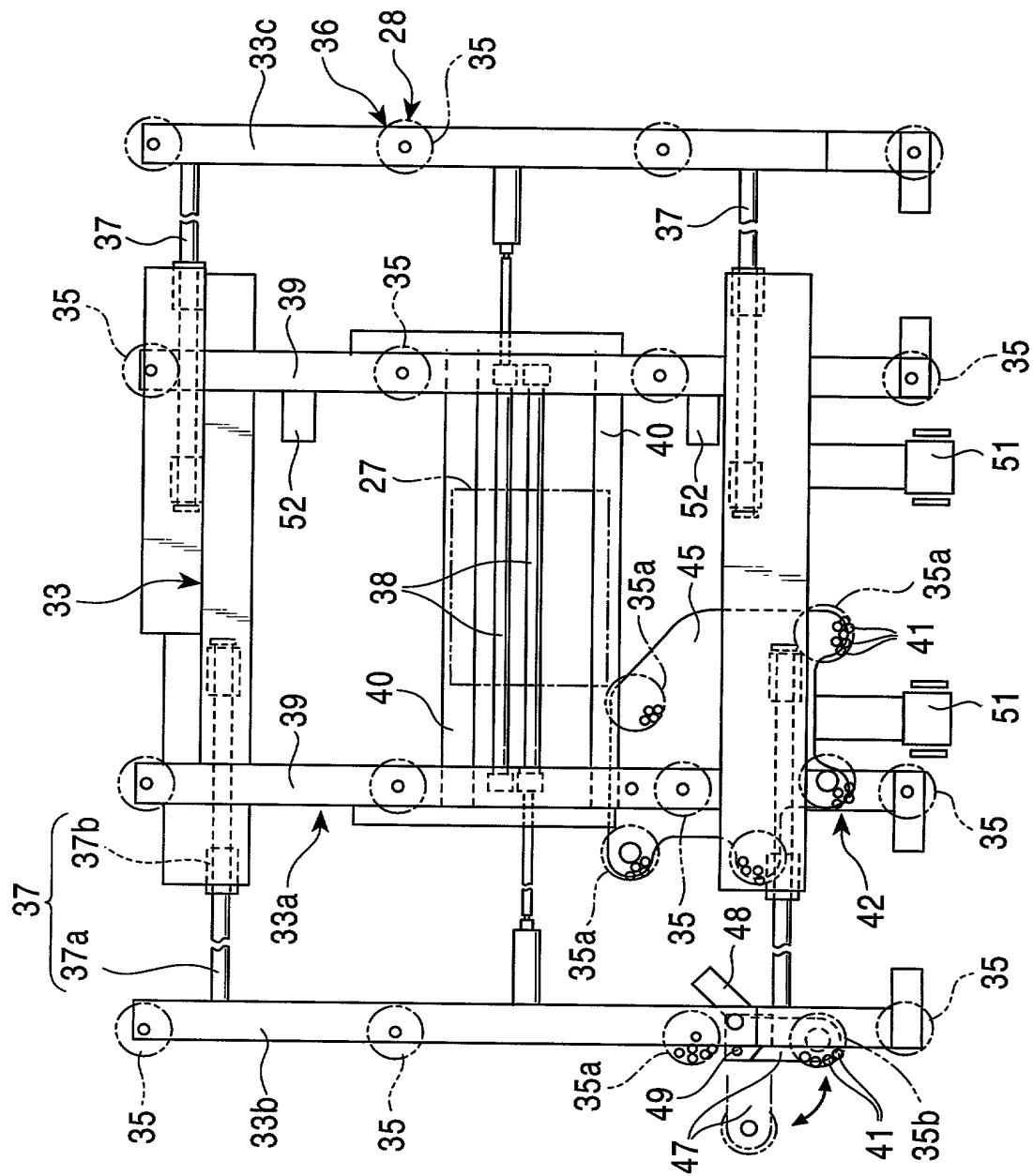


FIG. 6A

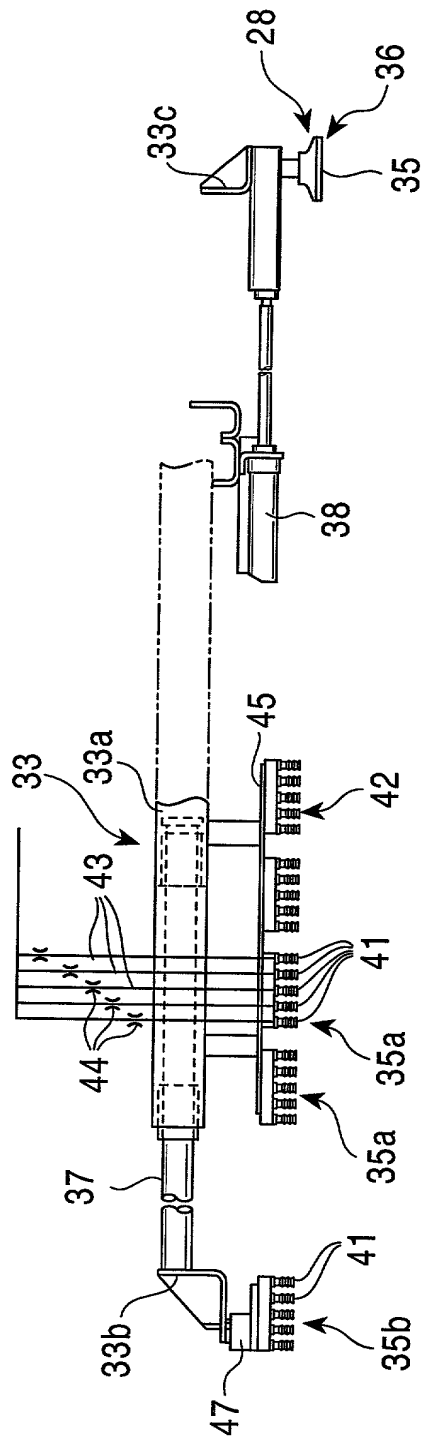


FIG. 6B

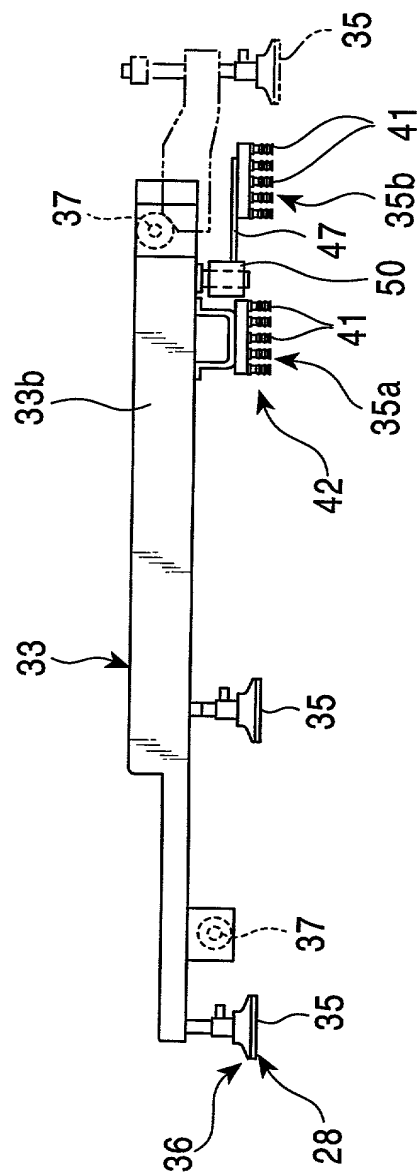


FIG. 7A

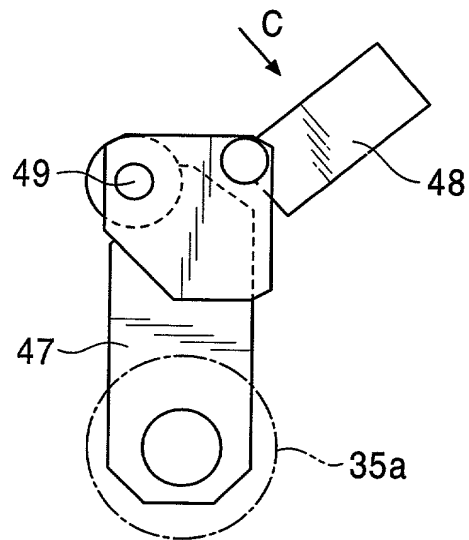


FIG. 7B

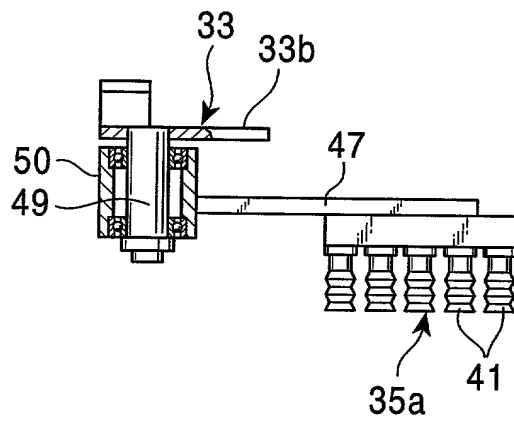


FIG. 7C

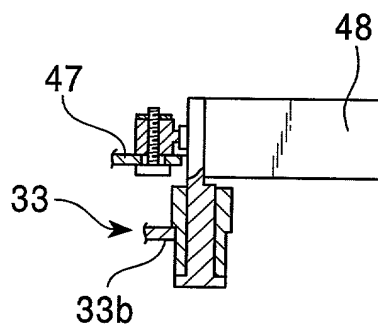


FIG. 8A

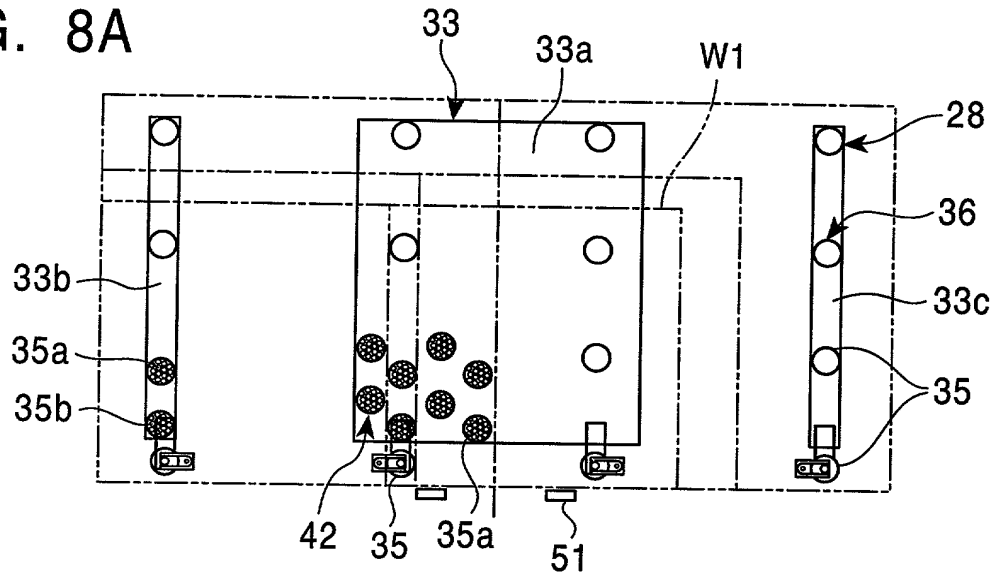


FIG. 8B

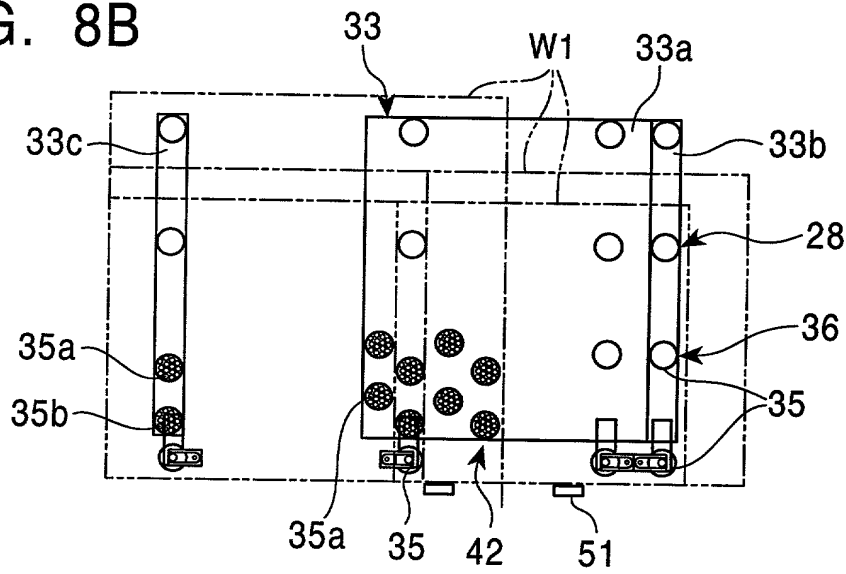


FIG. 8C

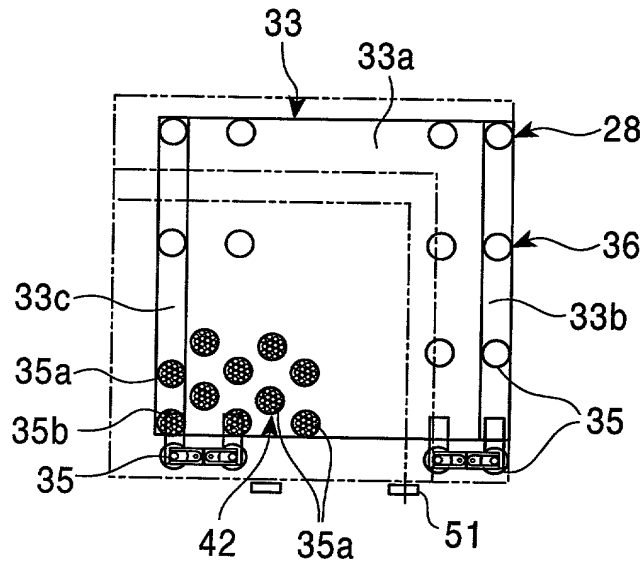


FIG. 9A

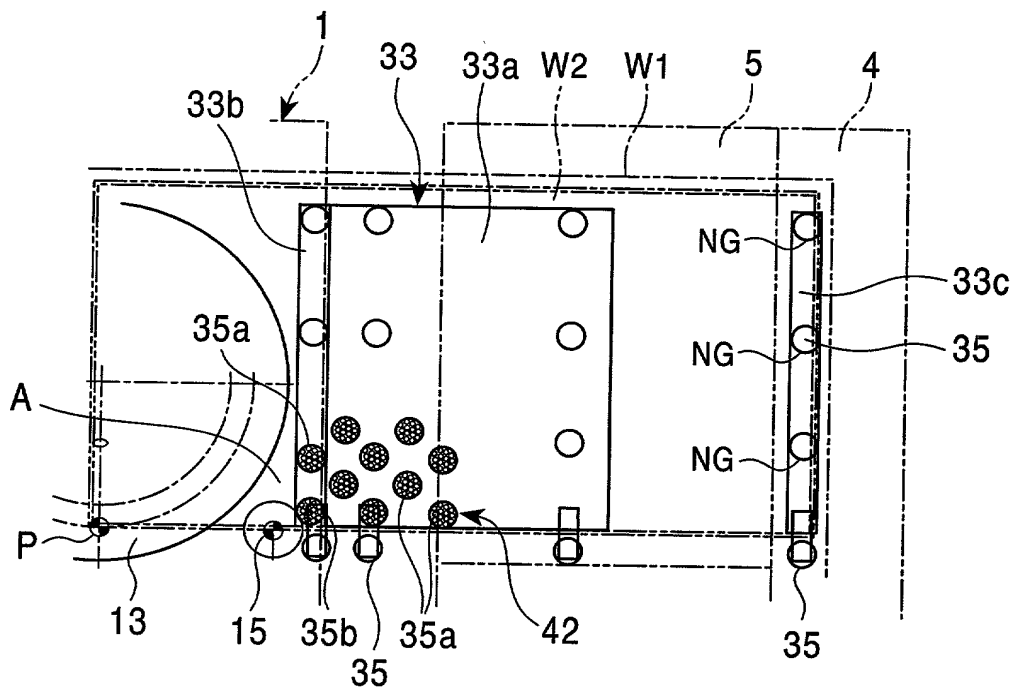


FIG. 9B

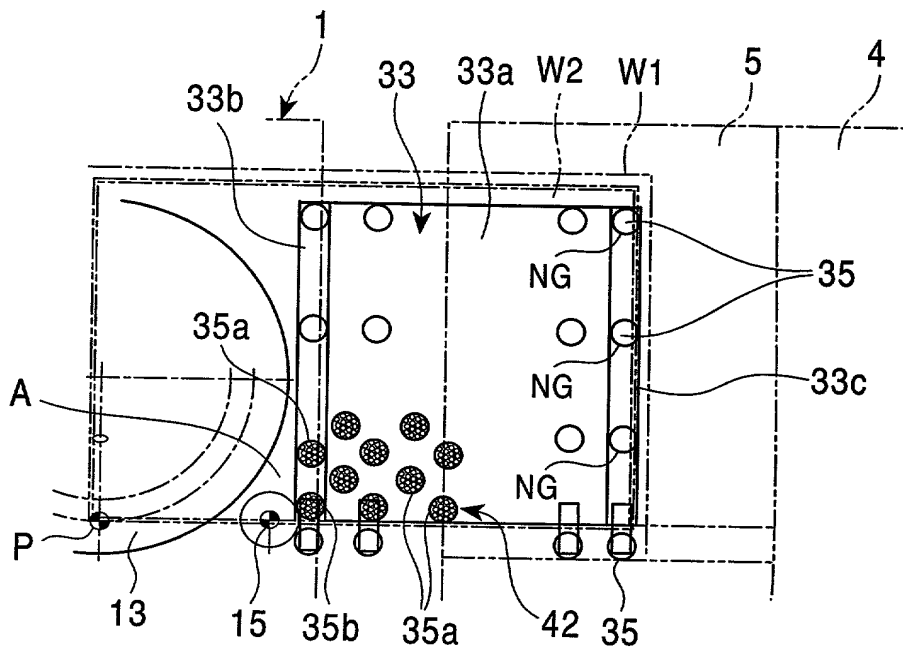


FIG. 10A

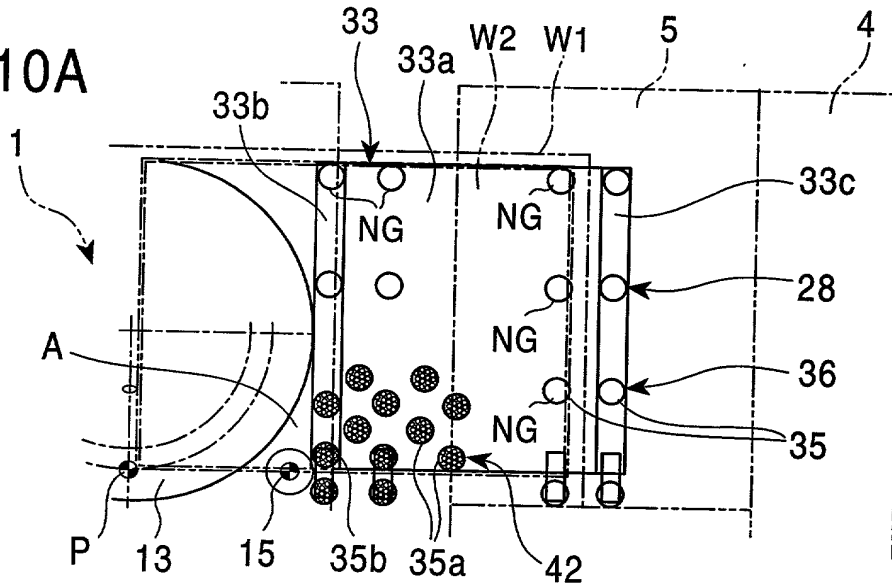


FIG. 10B

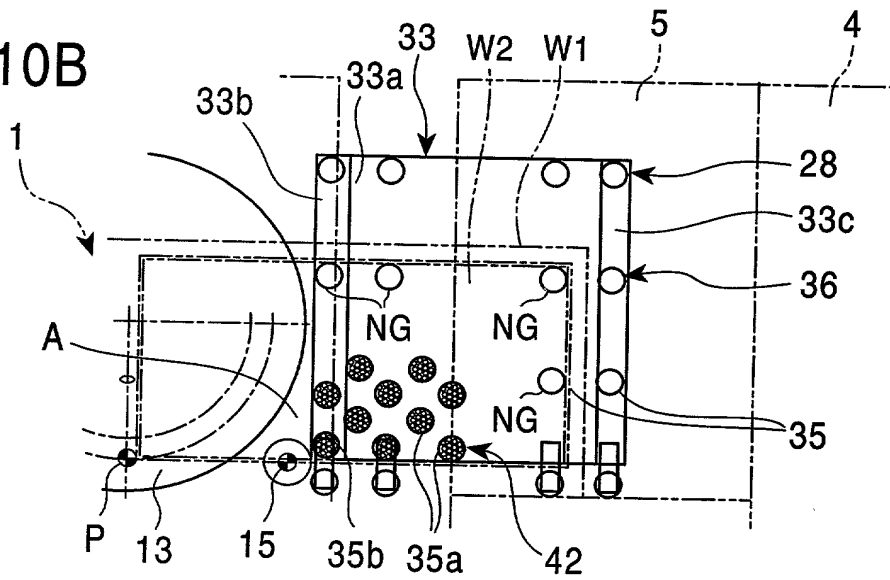


FIG. 10C

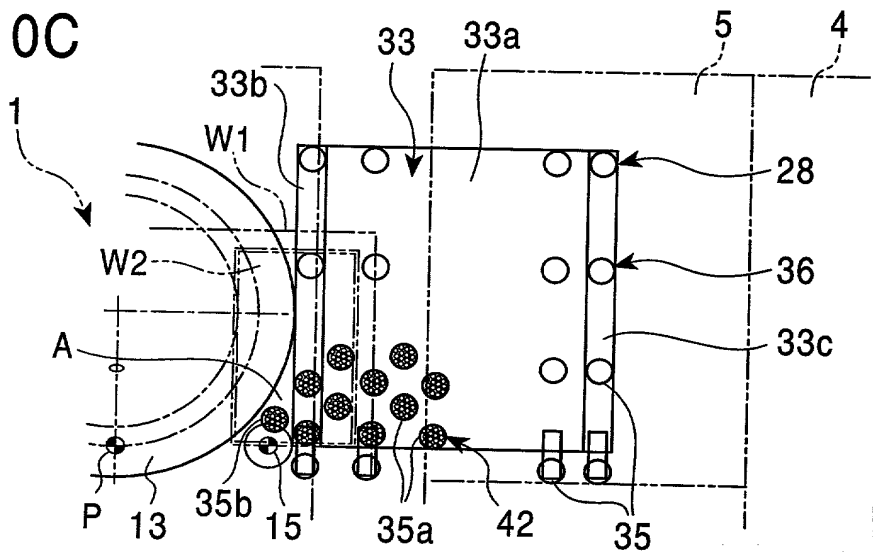


FIG. 11A

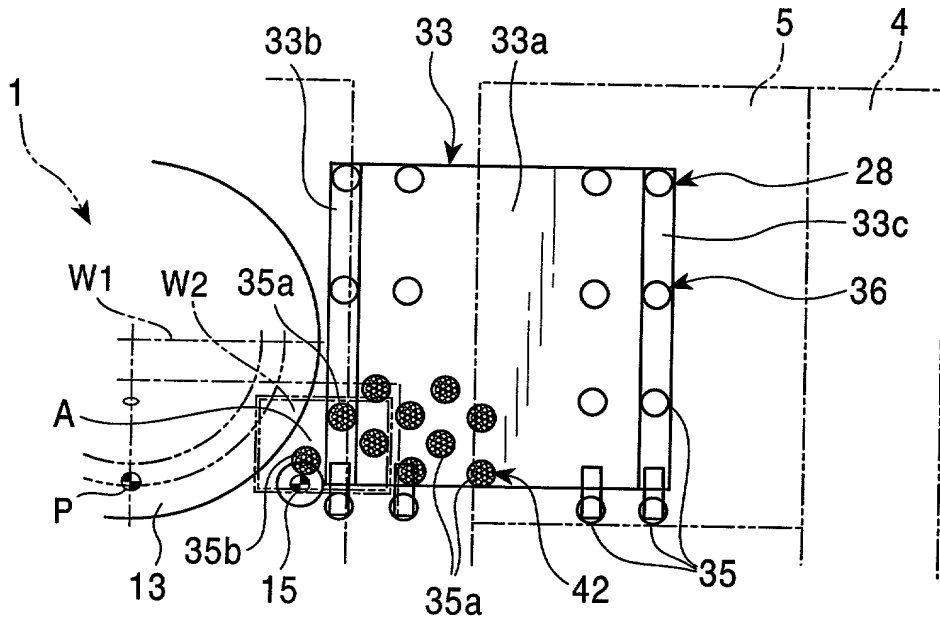
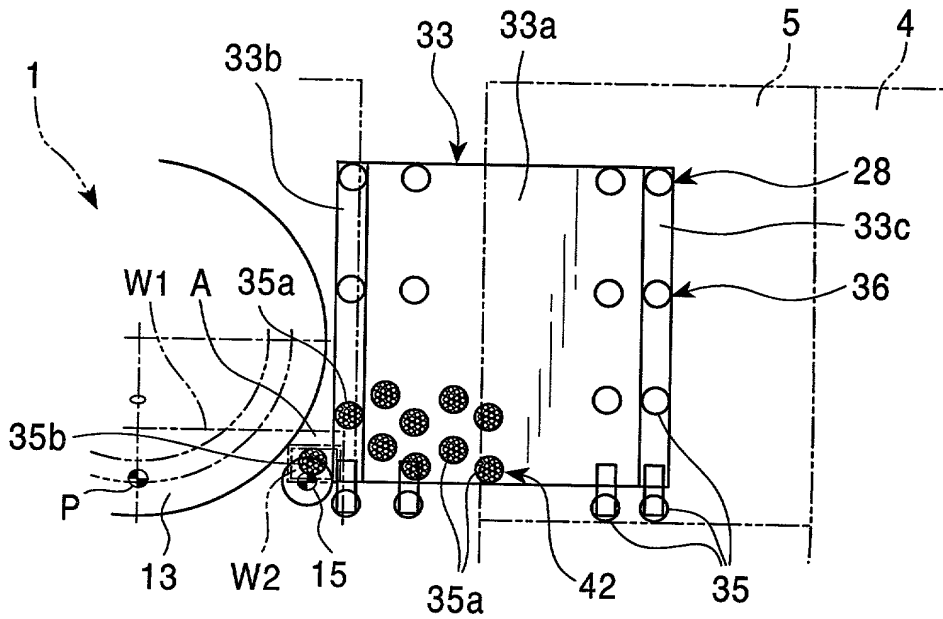


FIG. 11B



Declaration For U.S. Patent Application

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention **entitled**
(Insert Title) WORKPIECE-TRANSFER DEVICE

the specification of which is attached hereto unless the following is checked:

☐ was filed on _____ as United States Application Number or PCT International
Application Number _____ and was amended on _____
(if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 (a) - (d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

(List prior foreign applications. See note A on back of this page)	<u>10-287954</u> (Number)	<u>Japan</u> (Country)	<u>9/10/98</u> (Day/Month/Year Filed)	Priority Claimed <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
	_____ (Number)	_____ (Country)	_____ (Day/Month/Year Filed)	<input type="checkbox"/> Yes <input type="checkbox"/> No
	_____ (Number)	_____ (Country)	_____ (Day/Month/Year Filed)	<input type="checkbox"/> Yes <input type="checkbox"/> No
	_____ (Number)	_____ (Country)	_____ (Day/Month/Year Filed)	<input type="checkbox"/> Yes <input type="checkbox"/> No

(See note B on back of this page)

☐ See attached list for additional prior foreign applications

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below.

_____ (Application Number)	_____ (Filing Date)
_____ (Application Number)	_____ (Filing Date)

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of the application:

(List Prior U.S. Applications)	_____ (Application Serial Number)	_____ (Filing Date)	_____ (Status) (patented, pending, abandoned)
	_____ (Application Serial Number)	_____ (Filing Date)	_____ (Status) (patented, pending, abandoned)

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Title 18 of the United States Code, § 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor (given name, family name) Akio NAKAJIMA

(See note
C above)

Inventor's Signature Akio Nakajima Date 13/9/99

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Post Office Address Same as above

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Inventor's Signature _____ Date _____

Residence _____ Citizenship _____

Post Office Address _____

Full name of third inventor (given name, family name) _____

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____

Post Office Address _____

Full name of fourth inventor (given name, family name) _____

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____

Post Office Address _____

Full name of fifth inventor (given name, family name) _____

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____

Post Office Address _____

Full name of sixth inventor (given name, family name) _____

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____

Post Office Address _____

Full name of seventh inventor (given name, family name) _____

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____

Post Office Address _____

Full name of eighth inventor (given name, family name) _____

Inventor's Signature _____ Date _____

Residence _____ Citizenship _____

Post Office Address _____